This bald outline of Roberts-Austen's scientific work gives, however, a very inadequate idea of his diligence as a man of science or of the influence which he exerted on the progress of science. Such work as he engaged in was, from its very nature, time-consuming, and results were only obtained slowly and laboriously. From his official position, too, and by reason of his attainments, he was constantly pressed to serve upon committees, councils and commissions, into the work of which he never failed to throw himself with characteristic ardour and self-sacrifice. In 1885, he was a member of the executive council of the Inventions Exhibition. In 1889, he served on the British executive council of the Paris Exhibition, and in 1893 on that of the Chicago Exhibition. In the former year, he received the Cross of Chevalier of the Legion of Honour.

He sat with the writer on the Treasury Committee which preceded the establishment of the National Physical Laboratory, and he was also a member of the Board of Trade Committee appointed to inquire into the deterioration of steel rails during use in railway traction.

Since 1899, he had been a member of the Explosives Committee appointed to investigate explosives for use in the Army and Navy and material for the construction of guns.

Concurrently with the services he rendered to the State as a public servant, he did his fair share of labour in the organisation of scientific work as an executive officer of various scientific societies. He joined the Chemical Society in 1866 and served on its council in 1879-81, and became a vice-president in 1895-8.

In 1875 he was elected into the Royal Society, and served as a member of council in 1890-2, and at the time of his death was a member and chairman of some of its committees. He was one of the founders of the Physical Society, of which he was also a vice-president, and was an active member of the Society of Arts, of which he was a member of council and vice-president. He was also an honorary member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers and of the Institution of Mining and Metallurgy.

He was elected president of the Iron and Steel Institute in 1899, and held office until 1901.

In 1888 he was made a C.B., and received his knighthood in the order in 1899.

The University of Durham made him a D.C.L. in 1897, and a year or two later he received the honorary degree of D.Sc. from the Victoria University.

He was a frequent attendant of the meetings of the British Association, and served as one of the general secretaries of the council from 1897 to the year of his death.

His last public lecture was the James Forrest lecture on "Metallurgy in Relation to Engineering," given to the Institution of Civil Engineers on April 23. In special lectures of this kind, Roberts-Austen excelled. They cost him considerable effort, for he spared no trouble to make the occasion worthy of himself and of his subject, and he had his reward in the grateful appreciation of his auditory.

Indeed, no man discharged more faithfully, more honourably or more religiously the obligations he had incurred, or which, by virtue of his position, were thrust upon him. It may be truthfully said of him that whatsoever his hand found to do he did it with all his might.

No sketch of Roberts-Austen would be complete without some allusion to his remarkable social qualities. When at his best he was an admirable talker, bright, witty and amusing; he had a keen sense of humour and was a capital story-teller. He had a dangerous gift, however, which in his later years he was slow to make use of—he was an excellent mimic. In the old days—the days of Rankine, Lord Houghton, Clifford, Aitchison—when the "Red Lions" were wont to hold high carnival, Roberts-Austen occasionally would "let himself go" and exercise his gift to the uproarious merriment of jackals, cubs, lions and lion-kings alike. Indeed, it seemed at times that he was not quite conscious of the faculty he possessed. I have heard him, to my terror, in the course of a conversation gradually copy the tones and inflexions of a man's voice, and seen him reproduce his manner to his very face. There was absolutely no intention to be discourteous in this, and it was done so gradually and with such subtlety that the man was just as insensible of the fact as Roberts himself. I firmly believe that on such occasions the unconscious mimicry had its origin in sympathy.

Some years ago, Roberts-Austen acquired a small place at Chilworth, near Guildford, to which he would repair with Lady Roberts-Austen on all possible occasions. It never meant idleness to him, but there is no doubt that the occasional change from the atmosphere of Tower Hill to the breezy, invigorating air of a Surrey common had some effect in preserving him from the constant inroad he made upon his physical and mental energy. His social instincts made him a good neighbour, and he spent time and no inconsiderable amount of money in improving the lot of those around him. There was one side of his character of which only those who knew him well were made fully aware. It is reflected, however, in the beautifully decorated little chapel which he erected near his house for the benefit of the district, and in which he was wont to minister nearly every Sunday.

T. E. THORPE.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Monday, December 1, when the report of the Council was presented, and the members of the Council for the ensuing year, whose names have already been given (p. 35), were elected.

The first paragraph of the report refers to the formation of the "British Academy for the Promotion of Historical, Philosophical and Philological Studies" and its incorporation by Royal Charter. The President and Council of the Society were requested by the Privy Council to give their opinion upon a petition which had been presented to the Privy Council praying that the incorporation of the studies above referred to should be "provided for in some relation to the Royal Society." The report states that in the reply the Council of the Royal Society most strongly deprecated any change in organisation being imposed upon the Society from without in order that it might include within itself the studies for which the incorporation of the British Academy is asked, being convinced that such a change would destroy the independent position which the Society now enjoys as the head, in this country, of the mathematical, experimental and natural sciences. The Privy Council subsequently invited the opinion of the Royal Society upon a memorial suggesting that it would be desirable to attempt to organise officially in one institution the several branches of knowledge. The President and Council replied that they could not consent to the Royal Society forming one department of any institution or academy such as that suggested.

The statutes governing the election of Fellows under privileged conditions, under which members of the Privy Council have hitherto been admitted, have been amended. The principal amendment provides that the Council may, once in every two years, recommend to the

Society, for election as Fellows, not more than two persons who, in their opinion, have either rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society.

Among other matters, reference is made in the report to work carried on under the auspices of the Society in connection with malaria, sleeping sickness, the West Indian eruptions, the National Physical Laboratory, the International Catalogue of Scientific Literature, the Royal Society's Catalogue of Scientific Papers, Indian observatories and the International Association of Academies.

In the course of his annual address, the President made the following remarks upon the need for increased facilities and encouragement for higher scientific education and research :—

The supreme value of research in pure science for the success and progress of the national industries of a country can no longer be regarded as a question open to debate, since this principle has not only been accepted in theory, but put in practice on a large scale, at a great original cost, in a neighbouring country, with the most complete success.

The Physikalisch-technische Reichsanstalt of Berlin, largely due to the scientific foresight of von Helmholtz, was instituted in recognition of the principle that all the industrial applications of science rest on the foundation of pure scientific discovery. The institute has for its main objects, (1) the conduct of pure physical research, especially in such directions as are suggested by industrial questions: (2) the construction and supply of electrical and physical standards; (3) the verification of instruments of precision for scientific and technical purposes.

The original cost of the institute was more than 200,000*l.*, and its yearly maintenance is not less than 17,000*l.* During the five years that it has been at work, its influence upon the science and the manufacturing interests of Germany has been most remarkable. Besides the publication of numerous memoirs of original research and of papers on technical processes, the direct results of the work of the institute upon the industries of the country have more than justified the prevision of the founders; largely, we regret to say, to our own national loss, and to the almost complete passing to that country of the renown which was formerly ours in exact scientific measurements, and for the construction of standards and instruments of precision. So true is it, that the investment of public money in scientific research can only be compared to good seed cast into good ground, bringing forth in results a hundred-, or even a thousand-fold.

The sum voted by the Government for our own National Physical Laboratory, an institution second to none in its national importance, was the very modest one of 13,000*l.* for the buildings and equipment, and an annual grant of 4000*l.* for five years in aid of the expenses of conducting the work of the institution.

The supreme necessity in this country of a more systematic application of scientific methods, both in theory and in practice, to our manufactures and industries, which was so wisely insisted upon by the Prince of Wales on the occasion of his admission to the Fellowship of the Society and again in his address at the opening of the National Laboratory, has since been confirmed and enforced in a remarkable way by the individual testimonies of thirteen Fellows of this Society, in the evidence which they recently gave, from their own knowledge and experience, either as teachers of science or as leaders and technical advisers in manufactories or commercial undertakings, before a committee of the London Technical Board.

Their testimony was of no uncertain sound, but showed clearly that the Prince's words of warning were not unneeded, and that, indeed, our industries and commerce are not only in danger, but are actually passing into the hands of other countries, where scientific research is more directly cultivated under the fostering care of the State.

The undoubted present state of apathy of the national mind in relation to the importance of natural knowledge, and its consequent inability to recognise how entirely and without exception, in every undertaking, success must depend upon our so acting in conformity with the laws of Nature that we have her on our side, as our ally, and not working against us, may arise, conceivably, from either of two causes: from a natural want of enterprise and resourcefulness inherent in the national character, or from a system of education which, relatively to the educational training of other countries, fails to develop and strengthen the qualities of mind which are needed for an adequate appreciation of science.

The former of these two possible causes may surely be dismissed at once. We need only look back in history to see how this small northern island, by its own innate energy, has come to be supreme over vast regions on all parts of the earth's surface, and is now the head of an empire which engirths the world.

We are, therefore, left, without power of escape, to the second alternative, namely, that it is our system of higher education which is in fault, clearly through being too mediæval in spirit. In accordance with the traditions of the past, our higher national education deals with words rather than with things; it is based too exclusively on the memory of what is known, and too little, if at all, on individual observation and reasoning.

The evidence seems clear that the present inappreciative attitude of our public men, and of the influential classes of society generally, towards scientific knowledge and methods of thought must be attributed to the too close adherence of our older Universities, and through them, of our public schools, and all other schools in the country downwards, to the traditional methods of teaching of mediæval times. The incubus of the past makes itself felt, especially in the too strict retention of educational methods in which the first importance is given to the reproduction of knowledge from memory, to the acquiring and applying of what is already known; with little, if any, guidance and encouragement to the undergraduate student in the direction of research and of independent reasoning.

With the experience of Germany and the United States before us, the direction in which we should look for a remedy for this state of things would seem to be for both the teacher and the student to be less shackled by the hampering fetters of examinational restrictions, and so for the professor to have greater freedom as to what he shall teach, and the student greater freedom as to what line of study and research he may select as being best suited to his tastes and powers.

Into the dry bones of the present academic system of reading and examination must enter the living breath of the spirit of research, that is to say, of the individual efforts of each mind, for itself and in its own way, to seek to extend our knowledge in the direction most suited to its powers, by means of original observation and reasoning, and aided by the imagination—it may be in the field in science, of history and literature, or of art.

One way of bringing about reform in this direction would be to make individual research an indispensable condition of proceeding to degrees higher than the B.A.

In addition to the intellectual influence of a training in research upon the students themselves, the official recognition by the Universities of an original investigation of some subject, as a necessary condition of obtaining the higher academical honours, could scarcely fail to bring about in the public mind a more appreciative attitude in regard to the importance of original reasoning and discovery, and so to a better understanding of the meaning to be attached to natural science and to scientific methods.

It is obvious that with a fuller knowledge and appreciation of science on the part of the nation, a complete change of its practical attitude in respect to science and science questions would necessarily follow, for under such conditions public money would be liberally voted by the Government.

The work of this year's medallists was described as follows :—

COPLEY MEDAL.

Lord Lister, F.R.S.

The Copley Medal is awarded to Lord Lister in recognition of the value of his physiological and pathological researches in regard to their influence on the modern practice of surgery.

When in 1880 a Royal Medal was awarded to him, it was acknowledged that his researches had "not only reformed the whole art of surgery, but given a new impulse to medical science generally." The experience of another twenty years has written out that judgment in still larger letters. Lister's researches have made the world a wholly different world from what it was before.

The main result of those researches, namely, the definite proof that the suppuration of wounds, no less than putrefaction, was the work of living organisms, was not reached as a happy accident; it was the natural outcome of long-continued scientific observation and reasoning, the fruit of the labours of a well-trained scientific mind. Beginning with purely histological and physiological investigations having only an indirect relation to medicine and perhaps still less to surgery, he was gradually led, without changing his method or his mode of thought, to that which has so profoundly influenced both. His work has been a shining example of that which the Royal Society was founded to advance, the shaping of a new philosophy which is for the good of man.

RUMFORD MEDAL.

The Hon. Charles Algernon Parsons, F.R.S.

The Rumford Medal is given to the Hon. Charles Algernon Parsons for his success in the application of the steam turbine to industrial purposes, and for its recent extension to navigation.

The work of Mr. Parsons is of a kind which specially comes under the terms and conditions of the Rumford Medal, as consisting "of new inventions and contrivances by which the generation and preservation and management of heat and of light may be facilitated," and as "shall tend most to the good of mankind."

By his invention and perfection of the steam turbine, he has not only provided a prime mover of exceptional efficiency working at a high speed without vibration, but has taken a step forward which makes an epoch in the history of the application of steam to industry, and which is, probably, the greatest since the time of Watt. The success of the turbine is due to the experimental skill and inventive ability which have enabled him to overcome all difficulties, and to contrive a multitude of details without which the general idea of compound working could not have been translated into practice.

The use of the steam turbine for dynamo driving has been in operation for some time and is rapidly becoming common. Machines of 2000 horse-power and over are now being built. In accordance, however, with the conditions of the Rumford Trust, that the medal shall be awarded for work done within the previous two years, his claims to favourable consideration are based specially on the recent application of the steam turbine to marine navigation. The use of the steam turbine, as is well known, enabled the *Viper* and the *Cobra* to attain speeds hitherto unattainable. It has now been introduced within the last few years in vessels for mercantile purposes on the Clyde, and is being applied to ocean-going vessels.

ROYAL MEDAL.

Prof. Horace Lamb, F.R.S.

A Royal Medal is awarded to Prof. Horace Lamb for his investigations in mathematical physics.

Prof. Lamb has been conspicuous during the last twenty years by the extent and value of his contributions to mathematical physics. His writings have been distinguished by clearness, precision and perfection of form. His early work related to hydrodynamics, the "Treatise on the Motion of Fluids," published in 1879, being one of the first adequate accounts of the modern progress of that subject.

From 1881 to 1884, he published a series of memoirs dealing with the application of harmonic analysis to vibrational problems connected with spheres and other forms of bodies.

In these papers, subjects such as the subsidence of oscillations in viscous matter, the vibrations of spherical elastic solids, free electric vibrations and forced alternating currents were treated with full application to actual phenomena. In the memoirs on electrical motions and oscillations, he developed with remarkable completeness the application of Maxwell's electric theory in this department—including such topics as the surface-concentration of alternating currents—some years before the progress of the applications of electricity had led to independent experimental discovery of the importance of these phenomena.

In 1889-90, he published (*Proc.* Math. Soc. and *Phil. Mag.*) a number of valuable papers on the elastic deformation of plates and shells, which involved many new results, and also did much towards elucidating difficulties that had been encountered in this intricate subject.

Recent work has also included a discussion "On Reciprocal Theorems in Dynamics" (*Proc.* Math. Soc., 1888), a solution of the problem of the diffraction of a train of electric waves by a wire grating (*Proc* Math. Soc., 1898), and memoirs on the dynamical theory of the refraction and selective absorption of light by gaseous media (*Trans.* Camb. Phil. Soc., 1899, *Proc.* Math. Soc., 1900). In the latter subject, he traversed ground in which he afterwards found that he had been, to a considerable extent, anticipated (in Danish) by L. Lorenz.

His treatise on "Hydrodynamics," 1895, 604 pp. demy octavo, is universally recognised as the standard presentation of that subject. It maintains the best traditions of the British school of mathematical physics.

ROYAL MEDAL.

Prof. Edward Albert Schäfer, F.R.S.

The other Royal Medal is conferred upon Prof. Edward Albert Schäfer for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain.

Prof. Schäfer has contributed to animal physiology much work in various lines of research, and his discoveries regarding the nervous system have been especially numerous, from the time of his demonstration of nerves in the disc of medusa to his late work on the relation of the cerebral cortex of the ape to the sensory functions of the skin. Altogether, his neurological researches rank among the most important of contemporary British contributions to that branch of physiology. It is, however, especially for his work upon the functions of one of the ductless glands—the supra-renal—that he has a claim to recognition as a Royal Medallist. In 1894 he, in conjunction with Dr. G. Oliver, succeeded in demonstrating the existence in the cortex of the supra-renal gland of a substance, called now *adrenalin*, which is the most powerful known stimulant to the cells of visceral and vascular muscles. The discovery has since been confirmed by numerous workers, British and foreign; the original researches were, however, so accurate and exhaustive as to leave little further to be added by any means available at present. The work incidentally revealed absence of this active principle in the diseased supra-renal glands in *Morbus Addisonii*, a malady considered invariably fatal. The investigation laid the first real basis for knowledge of the functions of the supra-renal gland. Recently Prof. Schäfer has, working on lines similar to his adrenalin research, extracted from another ductless gland, the pituitary, a substance exhibiting marked properties as a diuretic.

DAVY MEDAL.

Prof. Svante August Arrhenius.

The Davy Medal is awarded to Prof. Svante August Arrhenius for his application of the theory of dissociation to the explanation of chemical change.

It is not easy to over-estimate the importance of the service rendered to chemistry by Prof. Svante Arrhenius through the publication of his memoir, presented to the Swedish Academy of Sciences on June 6, 1883, entitled "Recherches sur la Conductibilité Galvanique des Électrolytes." As far back as 1886, Sir Oliver Lodge, in referring to the second part of Prof. Arrhenius's memoir, in the Report to the British Association of the Committee on Electrolysis, spoke of it as a distinct step towards a mathematical theory of chemistry, and went so far as to say that "the title affixed to it is 'The Chemical Theory of Electrolytes,' but it is a bigger thing than this—it really is an attempt at an *electrolytic theory of chemistry*." This judgment has since been amply confirmed. Whether the theory be true or not in substance, it has proved to be a working hypothesis of the utmost value, having provided chemists for the first time with the means of fully discussing the phenomena of chemical interchange in dilute solutions of electrolytes mathematically.

Since 1883, Arrhenius has been constantly occupied in extending the application of the views put forward in his first paper.

The conception of the almost complete dissociation into their ions of strong acids and bases and of many salts in dilute solution was fully developed by him in 1887, almost simultaneously with van 't Hoff's extension of the gaseous laws to solutions.

The work of the two philosophers was, in fact, complementary, and the extraordinary development in recent years of physical chemistry must be attributed to the cooperative influence of their concurrent views.

DARWIN MEDAL.

Mr. Francis Galton, F.R.S.

The Darwin Medal is conferred upon Mr. Francis Galton for his numerous contributions to the exact study of heredity and variation contained in "Hereditary Genius," "Natural Inheritance," and other writings.

The work of Mr. Galton has long occupied a unique position in evolutionary studies. His treatise on "Hereditary Genius" (1869) was not only what it claimed to be, the first attempt to investigate the special subject of the inheritance of human faculty in a statistical manner and to arrive at numerical results, but in it exact methods were, for the first time, applied to the general problem of heredity on a comprehensive scale.

The work thus begun was continued and extended in a long series of publications (*see* Bibliography in "Natural Inheritance," pp 219-20), conspicuously in "Natural Inheritance" (1889), a publication which marks a distinct advance in these studies, both by definition of the problems of variation and heredity and by the introduction of novel methods. Subsequently Mr. Galton, with a greater emphasis, enunciated (Roy. Soc. *Proc.*, vol. lxi., 1897, p. 401) the central conclusion to which his long investigations had led him, in the form universally familiar to biologists as "Galton's Law of Heredity," a principle now recognised as of wide application in nature.

Contributing to the total of Mr. Galton's work, numerous other subjects might be mentioned, which he has elucidated with a genius peculiarly Darwinian. In all his researches he has been a pioneer, and indeed, with the single exception of Quetelet, we may almost say that no one preceded him. His work is generally acknowledged to constitute a new departure in biology, and to form a natural continuation of Darwin's labours. Besides their intrinsic value, the special charm of his writings has exercised a notable influence on the minds of others, stimulating them to work in the same fields. It may safely be declared that no one living has contributed more definitely to the progress of evolutionary study, whether by actual discovery or by the fruitful direction of thought, than Mr. Galton.

BUCHANAN MEDAL.

Dr. Sydney A. Monckton Copeman.

The Buchanan Medal, awarded every five years for distinguished services to hygienic science or practice, is given to Dr. Sydney A. Monckton Copeman for his experimental investigations into the bacteriology and comparative pathology of vaccination.

Dr. Copeman is well known, both in this country and abroad, for his contributions to the scientific basis and practice of preventive medicine. His earliest work in this field was an investigation into lead poisoning from drinking water in Yorkshire. The importance and value of his "Report to the British Medical Association" was such as to at once attract the notice of the late Sir George Buchanan, and he was shortly after appointed one of Her Majesty's Inspectors on the Local Government Board. Then he commenced, and in such leisure time as official duties have left him has continuously prosecuted with remarkable success, important researches into the nature of the vaccine *virus*, and on the contaminations, bacterial and other, of vaccine lymph. His work has, besides results of theoretic importance, brought practical results in the form of great improvements in the storage and preservation of lymph used in this country. He has also shown the possibility of obtaining useful vaccine lymph by passage through animals other than the calf. It may also be added that he has contributed a considerable amount of knowledge to the physiological chemistry of animal pigments, and has elaborated a test for distinguishing between the blood pigment of man and that of other mammals, a test which is practicable for medico-legal inquiries.

HUGHES MEDAL.

Prof. Joseph John Thomson, F.R.S.

The Hughes Medal is awarded to Prof. Joseph John Thomson in recognition of his contributions to the advancement of electrical science, especially in connection with the phenomena of electric discharge through rarefied gases.

The explanation of the brilliant and remarkable phenomena attending electric discharge through highly rarefied gas has long remained an enigma, though it was early recognised by Maxwell and other philosophers that the simplicity of the conditions that must prevail in rarefied matter would probably some day furnish the key to much that is fundamental in electrical action. Following at a considerable interval the earlier work of Plücker and Hittorf, the improvement in the production and regulation of high vacua led Crookes into the exploration of a new and very striking class of phenomena, those grouped around the kathode rays, and he adduced much evidence, backed by the authority of Sir George Stokes, to show that these rays consist of streams of electrified particles projected from the kathode to the electric current. The nature and origin of these torrents of particles remained an unsolved question. Though Schuster showed that some kind of subpermanent dissociation of electrolytic character accompanied the electric discharge, his admirably planned attempt to determine the relation between the charges and masses of the kathode particles did not lead to decisive results; while the advances made by Goldstein, Hertz and others in Germany were dominated by the view that the phenomena were due to disturbances propagated in the ether rather than to projected particles. When, in 1889, Prof. J. J. Thomson announced, as the result of his measurements of the magnetic deflection of the kathode rays, their relation to the rays of Lenard, and other properties, that each kathode particle carried the normal electrolytic molecular charge and moved with a velocity which was a considerable fraction of that of radiation, and more especially that the mass of the particles was only about the thousandth part of the mass of the chemical atom, it was felt that, if these conclusions were confirmed, experiment had forced a way into the very ultimate foundations of physical phenomena, into regions which might fairly have been thought to be beyond human scrutiny. Weighty evidence had indeed already been adduced on theoretical grounds that any complete and consistent rationale of the known electrical laws almost demanded that electricity should be of an atomic character, like matter itself; and the magnetic action in spectra, discovered by Zeeman, illustrated and directed attention to this result; but no presumption was anywhere entertained that the electrical atom could so soon become the subject of direct experiment. By virtue of Prof. Thomson's own investigations, and of many others inspired and stimulated by him, this new field of knowledge has been widely extended. It is now known that the conductivities induced in gases by the Röntgen radiation, by chemical action, by radio-active substances, even by a hot wire, are closely connected in character and all take place by electric convection of such ultimate atomic charges.

It can hardly be doubted that the progress of this new department of knowledge will gradually enable us to see one whole stage deeper into the sources of physical phenomena.

NOTES.

AT the meeting of the Royal Society on November 27, the following were elected by ballot foreign members of the Society:—Prof. Waldemar Christofer Brögger, Prof. Gaston Darboux, Prof. Ewald Hering, Mr. George William Hill, Prof. Albert Abraham Michelson, Baron Ferdinand von Richthofen, Graf H. zu Solms-Laubach, and Prof. Julius Thomsen.

THE Emperor of Germany never neglects an opportunity of expressing his appreciation of the important part which science plays in national progress, and his remarks are not only encouraging to workers in all departments of natural knowledge, but also of value in determining the attitude of the public towards scientific work. In a speech at Aix-la-Chapelle in June last, he described the German Empire as mainly intellectual and scientific, and on November 28 he alluded to the same point in the course of a speech delivered at Görlitz, where a "hall of fame" has been erected. From a translation of the text of his